

WHY WE SLEEP.

IT is related that a Chinese merchant, having been convicted of murdering his wife, the judges determined to punish him in such a manner as to inflict the utmost amount of suffering, and, at the same time, strike terror into the hearts of all those who might entertain the idea of following his example. He was, accordingly, condemned to die by being deprived of sleep. The prisoner was placed in confinement under the cans of three of the police guard, who relieved each other every alternate hour, and were instructed to supply him with a full allowance of food and drink, but who prevented him falling asleep night or day.

At first the condemned man congratulated himself on the mildness of his punishment, and was rather disposed to regard the whole matter as a joke. The excitement of his situation tended to keep him awake, and for a day or so his guards had little to do. By the third day, however, he began to feel very uncomfortable. His eyes were red, his mouth parched, his skin dry and hot, and his head ached. These symptoms continued to increase in intensity, and at the commencement of the eighth day his sufferings were so acute that he was at times delirious. In his moments of reason he begged the authorities to put an end to his torture. He implored them to grant him the blessed opportunity of being strangled, guillotined, burned to death, drowned, garroted, shot, quartered, blown up with gunpowder, cut into small pieces, or killed in any conceivable way their humanity or ferocity might suggest. All was in vain-his tormentors coolly did their work till there was no occasion for their interference. A period was reached at which he could not have slept even if let alone. The brain was feeding on the products of its own disintegration, and sleep was impossible. He was now entirely

insane Illusions of his sight and hearing were almost constant, and erroneous fancies filled his thoughts. At one moment he fought his guards with all the fury of a maniac; at the next he cowered with terror before some imaginary monster, and then, relapsing into calmness, would smile with delight at some enchanting vision which flitted through his mind. Finally, nature gave way altogether. He lay upon the floor of his prison, breathing slowly and heavily, stupor ensued, and, on the nineteenth day, death released him from his sufferings.

The story is probably founded on fact, for, of all the nations who have cultivated the subject of punishments as a science, the Chinese stand among the first.

But the question arises, Why should the mere deprivation of sleep be productive of such a degree of torture as to make the victim beg for some more speedy and apparently more horrible death? The answer involves certain facts connected with the physiology of sleep, which, it generally understood and acted upon by those who make much use of their brains would do a great deal toward lessening the population of our insane asylums.

The brain is the organ which evolves the mind. To perform its function, it requires to be supplied with a sufficient quantity of good blood. In this respect it does not differ from any other organ of the body. If the liver be deprived of blood, the secretion of bile stops; if the vital fluid be cut off from the stomach, there will be no more gastric juice; if the renal vessels be tied or divided, the action of the kidneys is at once arrested.

Now, within certain limits, the more blood there is in the brain, the more energetically does it work in the production of mind. It the

proper limit, however, be passed, and especially if the blood be “black” or non-aerated, the manifestations of mental action become abnormal, and may altogether cease through the stupor caused by congestion. In all these respects the brain is submitted to the same laws that govern the other organs. A moderate increase in the activity of the circulation in the gastric vessels leads to an augmentation in the quantity of gastric juice, and thus digestion is accelerated. A like cause acting upon the liver promotes the secretion of bile, and so on for the other organs. Let the Rubicon of healthy activity be passed, and the vessels become unduly overloaded, and we have bad gastric juice or bile, as the case may be, and, perhaps, none at all.

Mankind have found out certain ways of increasing the amount of blood in their organs, and thus of producing results which they deem beneficial or necessary. Thus, to help digestion, We eat cayenne pepper, mustard, and other condiments, or follow Paul’s advice to Timothy, and take a little wine for our stomach’s sake. When the mother’s breast fails in nourishment for her babe, we employ medicines which have the effect of reopening the fountains, simply by their influence on the circulation of the blood; where it is deemed necessary to increase the amount of saliva, and thus to eliminate certain poisons from the system, we “salivate” our patients with mercury—or, rather, we did, few of us do so now. The glands become enlarged by the increased amount of blood in their tissues, and the saliva is poured out in torrents.

We know, too, how to increase the amount of blood in our brains, and thus to add to the number and brilliancy of our thoughts. A glass of wine by its action upon the heart, causes it to beat with more force and frequency, and appears to especially act upon the cerebral circulation. Eugene Sue never wrote without a bottle of

champagne by his side, from which he imbibed a great part of his genius. Others take opium for the same purpose; and others again resort to still more dangerous means. One of the most effectual and safest is a cup of strong coffee. Sydney Smith said, "If you want to improve your understanding, drink coffee" and Sir James Mackintosh used to declare that he believed the difference between one man and another was produced by the quantity of coffee they drank.

Then, again, the quantity of blood in the brain is increased by those portions of the body which mechanically favor its entrance into the cranium, or retard its exit. Many persons have noticed the influence of position on the activity of thought. Pope used to lie awake at night thinking. and, when a particularly brilliant thought occurred, would ring for pens, ink, and paper, in order that he might record it ere it was lost. The engineer Brindly used to retire to bed for a day or two, when he was reflecting on a grand or scientific project. Sir Walter Scott has said that the half hour passed in bed, after waking in the morning, was the part of the day during which he conceived his best thoughts. Tissot states that a gentleman, remarkable for his accuracy in calculation, for a wager, lay down in a bed and wrought by more strength of memory a question in geometrical progression, while another person in another apartment performed the same operation with pen and ink. When both had finished, the one who had worked mentally repeated his product, which amounted to sixteen figures, and, insisting that the other gentleman was wrong, desired him to read over his different products. On this being done, he pointed out the place where the first mistake lay, and which had run through the whole. He paid very dearly, however, for gaining his wager, as for a considerable time he had a swimming in his head, pains in his eyes, and severe headaches upon attempting any mathematical labor. A

gentleman has recently told the author that, whenever he is at a loss for ideas in his literary compositions, he lies down on a lounge, and always with good results.

But the blood in the brain may be increased by its own action. Intense and long-continued thought, anxiety, grief, and other emotions, have this effect. It may be laid down as a law admitting of no exception, that, when an organ is kept in a condition of great activity, there is an augmented flow of blood to its substance; and the organ, whatever it is, increases somewhat in size when an increase is possible. Take, for example, the arm of a blacksmith, or the leg of a ballet-dancer. Here the excessive use to which the muscles are put causes an increased flow of blood to the part, and the consequent formation of new matter in greater proportion than it is consumed.

There can be no muscular action, except as the consequence of the disintegration of a certain amount of muscular tissue. No gland can act without its substance becoming decomposed to some extent, and no thought can be conceived by the brain without the destruction of a definite amount of the cerebral matter.

During wakefulness, the brain is constantly in action. There is not a moment during which it is entirely quiescent. If our thoughts are active, or if strong emotions act upon us, the blood flows in increased amount to the head, in order that new matter may be deposited to take the place of that which has been used. For all new substance, whether of the heart or the lungs or the brain, or the muscles, or the nerves, comes from the blood.

In the ordinary course of our lives the supply equal to the demand. But it is possible soto use our brains that the substance is destroyed

in a greater proportion than the blood can supply. Men engaged in the feverish and anxious occupations of life rarely stop to think that they are using their brain capital, instead of merely consuming the interest, as they ought to do. The end for all such is not far distant. It is a certain as the result of spending a pecuniary capital instead of living upon the income. The one will inevitably lead to insanity or a lunatic asylum: the other to pauperism and the almshouse.

Now, what has all this to do with the question, Why do we sleep? Simply this: sleep is the rest of the body, and especially of the brain. During this condition the brain is at its minimum of activity. Certain faculties, such as the imagination, appear to be in full operation, but it is in appearance only, for those faculties which regulate it when we are awake have their actions suspended. All other organs have their periods of rest during wakefulness, except the brain. Sleep is essentially the condition in which the noblest organ of the body reposes from its labors. It is then that the blood deposits new cerebral matter faster than it is used, and thus prepares the brain for its new duties when we awake.

If we take the hours which should be devoted to sleep and use them in mental activity, we are robbing our brains of the opportunity for regeneration which the condition of sleep affords. We are surely consuming our capital, brain—and intellectual bankruptcy is the certain result. If we persevere, the time is reached when we cannot sleep. For the cerebral vessels become so permanently distended that sleep is an impossibility.

It used to be thought that during sleep there was an increase in the quantity of blood circulating through the brain, but very smart observations have satisfied us that the reverse is the case. Wakefulness, therefore, keeps the cerebral vessels distended, a

state of congestion is thus induced, the blood is not rich enough in the substances the brain requires to supply its wants, and this organ accordingly consumes its tissue for the restoration of mind, without the possibility of sufficient deposits being made to compensate for the loss.

Is it a matter for surprise that, under such circumstances, the brain should act badly, and that the manifestations of mental action should exhibit irregularity and disorder? Is it a wonder that a man who has passed a sleepless night should be unable to transact his business properly the next day, or even to add up a column of figures correctly? Is it strange that his head should feel dull and heavy, that he cannot collect his thoughts, or even concentrate his attention upon matters requiring deliberation? Let this go on night after night, and organic diseases of the brain, such as insanity, inflammation, or softening, are certain to result. We sleep, therefore, mainly to give the brain rest. One-third of our lives should be devoted to this purpose. If this is done, it matters not how constantly or intensely we employ that organ which, in its noblest proportions and in its fullest vigor, makes man what he is.

THE THEORY OF SLEEP.

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WHAT PART IS IT THAT SLEEPS?

FOR the developed consciousness of a highly-organized animal, there is no rest in the waking state. Impressions are continually pouring in through one or other sense-avenue, which stimulate and keep up trains of thought. So that, if occasional periods of rest are desirable for all organs, it would only seem possible to bring this about, in the case of the brain, by some mechanism which should practically deaden the sensibility of the sensorium, or nerve-centres, upon which stimuli, acting through the senses of sight, hearing, smell, taste, or touch, impinge. In this way consciousness would be for a time blotted out, and the function of thought held in abeyance. This, as I shall now attempt to show, is the object and nature of the state of sleep. It is a condition due to the temporary and periodical inactivity of the most specialized portion of the nervous system, the brain; and the slumbering insensibility of this highest organ of animal life involves, as a consequence, a similar state of inactivity for the other organs of relation, while the functions of mere vegetative life are carried on in the usual way; the heart beats, the lungs perform their accustomed functions, and most of the glandular organs elaborate their secretions, as in the waking state. Thus, although it is usual to speak of the individual as sleeping, it is really only his or her brain and its immediate dependencies, the sense-organs, which sleep. It is for the brain alone that this special provision requires to be brought about, on account of the delicacy of its organization, and the subtle and peculiar nature of the functions which it performs. Consciousness itself must be deadened, if the organ of consciousness and thought is to obtain that rest which is necessary for the continuance of its functional activity. We do not mean to say that other parts of the

body do not also share in the advantages which are to be derived from periodical sleep. The voluntary muscles, for instance, must benefit by this period of rest, when nutritive repair may take place more effectually in those which have been especially called into ' action during the previous day. But the various muscles, even during our waking state, have also their periods of rest; we are not always engaged in muscular exertions, and, when so employed, alternate demands are made upon different sets of muscles—so that periods of sleep are not so necessary for the restoration of vigor to our voluntary muscular system. And even those purely organic functions, the continuance of which, depending upon the action of involuntary muscles, is necessary for the well-being of the individual, are intermittent rather than strictly continuous. Thus, the pulsations of the heart, and the movements of respiration seem continuous, but still there is even with them a periodicity which is able to include, between the successive actions of these organs, distinct periods of rest. It can be easily computed that the diurnal aggregate of these periods of rest for the heart would amount to no less than six hours, and, for the muscles concerned in respiration, even a still longer period. Glands, also, have their periods of rest and activity in the waking state; while for the brain, as we have before shown, the only possibility of repose, and any thing like complete rest, is to be found during sleep, when consciousness and thought are in abeyance.

THE CONDITIONS OF ACTIVE CONSCIOUSNESS.

How, then, is this state of unconsciousness induced? To enable the reader to understand the reply which is to be given, a few other fundamental facts in physiology must be briefly alluded to.

The action, or what is called the functional activity, of an organ

depends upon its being maintained in a due state of nutrition ; for, if the structure of an organ is defective, or spoiled, by virtue of a faulty nutrition, we can no more expect it to act in a proper manner than we can expect a watch to keep accurate time when its mechanical adjustments are either broken or out of gear. Or, to take an illustration which elucidates our present meaning better: just as no one would expect a steam-engine to continue in activity after the supply of coal had been stopped, the combustion of which furnishes its motive power, so it could not be expected that any organ of the body would continue to perform its accustomed actions or functions after that which supplies its motive power has been cut off. Now, in the case of animal organs, the blood supplies the pabulum, which serves as fuel in enabling them to continue their functions—under the special guidance and control of one of them—the central nervous system. For, as we have before said, every action taking place in a living being is possible only by the death and molecular resolution of those portions of tissue-elements which occasion the vital manifestation; and this great law of life involves the further necessity of constant and molecular nutritive repair, if the functional and structural integrity of the organs is to be maintained. The material for this repair is supplied by the blood, which is impelled, by the contractions of the heart, through a system of closed tubes lying among the elements of almost every tissue of the body. These blood-vessels have muscular and contractile walls, and gradually diminish in size till they terminate in a dense network of capillary canals, having thin membranous walls, through which the nutritive juices are enabled to exude, so that they may be taken up by the tissue-elements among which the capillaries lie. It is now well known, also, that one of the most obvious duties of the great sympathetic system of nerves and ganglia (the nervous system of organic life) is to regulate the calibre of these contractile tubes, through which blood

is conveyed to the various organs of the body. By the stimulation of certain parts of this nervous system of vegetative or organic life, the vessels which receive their nerves from the parts stimulated may be seen to contract and notably diminish in size; while if the ganglionic nervous influence is cut off from these vessels, by section of the nervous trunks going to them, then, on the contrary, the same vessels are seen to dilate to a diameter even beyond that which is natural to them. By a mechanism such as this, therefore, great differences may be brought about in the amount of blood sent to an organ, according to its varying degrees of functional activity at different times, and its corresponding need of a greater or less supply of nutritive fluid to compensate for the molecular waste which it is undergoing. And it may be laid down, indeed, as a general rule, that the more active the organ, the greater is the supply of blood which is sent to it, the quantity actually sent being regulated to a nicety by a most complex but marvellously-adapted nervous mechanism.

THE CAUSE OF SLEEP.

Now, the state of sleep, as we have before specified, is one which is essentially characterized and produced by a more or less complete arrest of the functions of the brain, the organ presiding over the functions of animal life. How, then, is this arrest of function brought about? The answer most likely to suggest itself to any reader of this paper would probably be, by a diminution in the amount of blood sent to the organ. But, curiously enough, it is only within the last ten years or so that physiologists have begun to entertain this view. It was formerly thought that the state of sleep depended upon a congested condition of the vessels of the brain; that is, upon their being more or less distended with blood, moving, however, with less rapidity than natural. This distention, with slow movement of

the blood, would, it is true, be unfavorable to the functional activity of the organ; and then, in addition, it was maintained that the pressure on the delicate brain-tissue produced by the distended vessels was in itself an even more powerful cause of sleep. On this theory it was difficult and almost impossible to account for the production of the congestion, and there is reason to believe that the efficaciousness of pressure upon the brain-pulp, in bringing about sleep, was maintained principally under the influences of a false but supposed analogy existing between this normal physiological condition and certain states of disease which are especially characterized by the most profound unconsciousness. These states are known by the names of stupor and coma, and it is perfectly true that they may be induced by undue pressure upon the brain, occasioned by portions of depressed and fractured skull, for instance; while it is also true that in other cases such states are accompanied by a very full and distended condition of the vessels of the brain, with dark-colored and more or less impure blood. But the fact that sleep is produced in quite a different way rests principally upon the results of observation and experiment. Even Blumenbach, in the end of the last century, advocated the view that the proximate cause of sleep was a diminished flow of blood to the head ; a view which he was led to entertain from observations made upon a young man who had fractured his skull. Dendy, also, states that in 1821 there was a woman at Montpellier, who had lost part of her skull, so that the brain and its membranes were partly laid bare. "When she was in deep sleep," it is said, "the brain remained motionless beneath the crest of the cranial bones; when she was dreaming, it became somewhat elevated; and, when she was awake, it was protruded through the fissure in the skull." But, in 1860, Mr. Durham proved experimentally that in certain animals during the state of sleep the vessels on the surface of the brain were notably smaller, and contained less blood, than when the

same animals were awake. Dr. Hammond, of New York, also, shortly afterward, by somewhat similar experimental researches, was enabled to corroborate the conclusions arrived at by Mr. Durham. And now, these observations, together with others of a somewhat similar nature, having gone so far to show that the brain contains notably less blood in its vessels during sleep, the doctrine may be said to be fairly established that a comparatively anemic or bloodless state of the brain is the principal determining cause of sleep, we are thus left free to inquire, What is the actual cause of that diminution in the blood-supply which induces this state?

PHYSIOLOGY OF GOING TO SLEEP.

AN interesting little book has recently been published by Mr. C. H. Moore ("On Going to Sleep"), in which he endeavors more especially to answer this last question. He insists, as we think, very properly, upon the fact that the transition from a condition of wakefulness to one of sleep is really at the last an abrupt change of state, and therefore one which cannot be adequately accounted for by relying upon such general causes as weariness or fatigue of body and mind. All these, it is true, are powerful predisposing causes, but the immediate effective cause must be something more specific; and there are many reasons for believing that this is the discharge of a stimulating influence from certain ganglia of the sympathetic system in the neck along those nerves which are distributed upon and regulate the calibre of the arteries that supply the brain. The effect of this outgoing stimulus is to cause a diminution in the calibre of these arteries, so that they carry to the brain a smaller quantity of blood—a quantity inadequate to maintain the functional activity of the organ, and therefore leading to a state of

unconsciousness, though perhaps sufficient to enable the nerve elements to undergo that amount of nutritive molecular repair which shall fit them for the activity they may be called upon to display on the morrow. It seems probable that there is a kind of inverse relationship existing between the activities of those parts of the sympathetic nervous system which supply the cerebral arteries and the cerebrum or brain itself— a kind of antagonism between the nervous system of organic and that of animal life. And it is perfectly consistent with other known physiological phenomena for us to imagine that in general, so long as we are awake, and the brain is in a condition of functional activity, an influence emanates from it along those nerve-filaments by which it is in connection with the cervical sympathetic ganglia of a repressive, or, as physiologists would say, of an inhibitory nature. Although such a communication cannot be actually demonstrated, yet various reasons lead us to believe that it almost certainly exists through the intermediation of fibres passing through the upper part of that elongated continuation of the brain known as the spinal cord. So long as this inhibitory stimulus streams down from the active brain above, the action of the cervical sympathetic ganglia is restrained; but when, after the fatigues of a day spent in more or less bodily and mental exertion, the vigor of the brain is diminished (as the relaxed or wandering attention testifies), then there comes a moment of abstraction, when the action of the brain is so slight that the inhibitory influence proceeding from it is no longer capable of holding in check the sympathetic ganglia. These, set free from the cerebral influence, begin to discharge their accumulated force, so as to lead to a contraction of the cerebral arteries and a diminished supply of blood to the brain. This lowered supply of blood necessarily leads to a still further diminution of brain energy, and thus the freedom of the cardiac ganglia from cerebral control is rendered more perfect, and the condition of sleep the more sound.

PHYSIOLOGY OF WAKING UP.

After hours of repose, however, during which we must suppose nutritive repair has been taking place, the irritability of the nerve-cells in the brain has been restored to its maximum condition, so that they are now rendered capable of responding to such slight impressions, through one or other of the sensory organs, as would have passed utterly unnoticed soon after sleep had been induced. Now, some slight impression, whether of sight, sound, or touch, is capable of arousing the consciousness, and completely putting an end to that state of sleep which had for some time previously been gradually growing less and less sound. The brain is again in activity, the sympathetic ganglia are once more subordinated, so that the cerebral arteries have re dilated, and thus the supervention of the state of wakefulness is at the last more or less sudden and abrupt, just as we have seen that the final transition from the waking to the sleeping state was an abrupt one. The slight impression upon the reinvigorated sensorium must have exercised a paralyzing influence upon the cervical sympathetic ganglia sufficient to cause the re dilation of the cerebral vessels, and its consequence a state of wakefulness.

Space will not permit of our going into details concerning the state of sleep itself and the phenomena of dreaming. We will only say that, from a consideration of many facts, it seems more than probable that certain parts of the brain may sleep while others are awake, and that great variations in this respect take place during the total period of sleep; all these tending to show that the branches of the cerebral arteries have separate and smaller nerve-centres (all in connection, however, with the great cervical ganglia), so that certain of the arterial branches may remain dilated, while

others are in a state of contraction

We can only allude, also, to the different requirements of different individuals as regards their amount of sleep—differences dependent upon age, mental activity, and other circumstances; and to the remarkable instances on record in which sleep has supervened in the most exceptional circumstances—even as in the case of Damiens, in the midst of the most diabolical tortures on the rack. These anomalies are much more capable of explanation from a consideration of the theory of sleep which we have just been unfolding, than if we attempt to account for them by a reference to any of the views concerning this mysterious state which have hitherto been in vogue.

REPEATED AND PROLONGED VIGILS.

THE Abbé de la Caille, a famous astronomer, invented a kind of fork in which he adjusted his head, and thus passed nights in observation of the sky, without knowing any other enemies than sleep and the clouds, and without suspecting that there was a sweeter employment of those silent hours which revealed to him the harmony of the world. He contracted in this way an inflammation of the chest, which carried him off in a few days. The painter Girodet did not like to work in the daytime. Seized in the middle of the night with a fever of inspiration, he would rise, light lustres suspended in his studio, set upon his head an enormous hat covered with wax-lights, and in this singular costume he would paint for whole hours. As might be expected, few have had more wretched constitutions or more dilapidated health than Girodet. Toward

the end of his short life his genius seemed wedded to a corpse.

The cruel wakefulness that torments thinkers wears out life indeed with fearful rapidity, whether by shortening its duration or by diminishing its effective power. Vigils, while depriving the body of rest, overexcite the cerebral activity, augment that enormous expense of nervous energy made in the work of thought, and keep up a fluxion of blood to the head. They thus prevent repair of the waste of force, or at least oppose a complete restoration of power (since this requires in sleep a collapse of the brain by diversion of its circulating volume toward other viscera). Often, indeed, the thinker, wearied and overcome, leaves his work, to court sleep. But sleep shuns him, the wished-for calm comes not, the excited circulation of the brain continues. That cerebral tension, so much coveted in order to produce and to combine ideas, continues the master where it was invoked as the servant. At last, after the lapse of many wakeful nights, a restless, troubled sleep imperfectly repairs the forces destined to be again consumed. "Such nights abridge our days," says Bacon. How dear Nature makes us expiate our contempt for her laws and her lessons!

In the works of men of letters, of orators, and poets, every chapter, every paragraph, is the investment of a portion of their life. Goethe lived long, notwithstanding his immense labors, and yet the excitement of his brain, when at work, almost always led to accidents; the composition of each of his great works was followed by a malady. Woe to those imprudent vanities that would supply by a forced labor what Nature has refused them!

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